PRODUCTION ENGINEERING LABORATORY — SECTION 4

Surface Production Tools

Restoration, Function, and Field Reference

Restored tools — Production Engineering Laboratory, DUIET

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1. Introduction

This document covers the surface production and wellhead tools restored as part of the Production Engineering Laboratory development exercise — the valves, chokes, fittings, and hangers that control and direct produced fluids at surface, from the wellhead through the Christmas tree. Each entry includes function, working principle, a schematic, and QR-linked video/reference material.

2. Gate Valve

A gate valve uses a flat or wedge-shaped gate that slides perpendicular to the flow path to fully open or fully close the line.

2.1 Working Principle

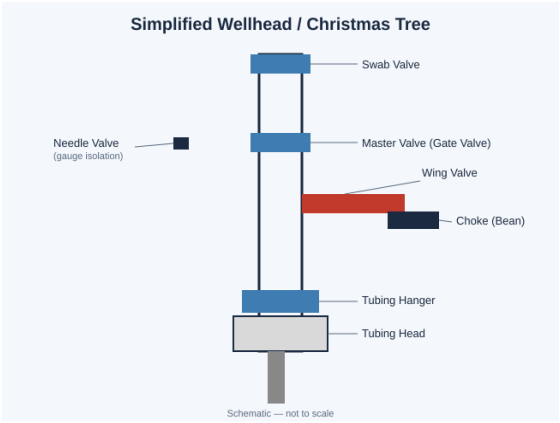
Turning the handwheel raises or lowers the gate inside the valve body via a threaded stem. When fully raised, the gate is clear of the bore, giving a full, unobstructed flow path with minimal pressure drop; when fully lowered, the gate seats against the bore and blocks flow completely. Gate valves are designed for on/off (block) service and are not intended for throttling, since partial opening causes turbulent flow that can erode the gate and seat.

2.2 Where Used

Gate valves are the standard master valve and wing valve on wellheads and Christmas trees, chosen for their full-bore, low-pressure-drop design when open and their reliability for repeated open/close cycling over a well's life.

2.3 Restored Tool — Photograph & Schematic

Gate Valve, restored — Production Engineering Laboratory, DUIET



Gate valve position in wellhead stack

2.4 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Gate valve wellhead working — search (YouTube)

Reference: Wellhead Equipment Installation Procedure (Landrill Oil Tools)

3. Needle Valve

A needle valve uses a slender, tapered plunger (the “needle”) that seats into a matching conical orifice.

3.1 Working Principle

Turning the handwheel advances or withdraws the needle into the orifice. Because the needle's taper changes the effective flow area very gradually as it moves, needle valves allow extremely fine, precise control of small flow rates — a capability standard gate or ball valves cannot match.

3.2 Where Used

Needle valves are commonly fitted on instrument lines, sample points, and pressure-gauge isolation connections, where exact metering or a reliable shutoff for delicate instrumentation is required.

3.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Needle valve working animation — search (YouTube)

Reference: Types and Applications of Choke Valves (What Is Piping)

4. Ball Valve

A ball valve uses a bored sphere (the “ball”) mounted inside the valve body.

4.1 Working Principle

Rotating the handle a quarter turn (90°) rotates the ball: when the ball's bore aligns with the pipe axis, flow passes through with minimal restriction; rotated 90° from that position, the solid face of the ball blocks the bore completely. This gives rapid, low-torque, full-bore shutoff in a single quarter-turn motion.

4.2 Where Used

Ball valves are favoured wherever quick, reliable on/off operation is needed, including many production and test-line applications.

4.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Ball valve working animation — search (YouTube)

Reference: Types and Applications of Choke Valves (What Is Piping)

5. NRV (Non-Return Valve)

A non-return (check) valve allows flow in only one direction and closes automatically against any reverse flow.

5.1 Working Principle

An internal flapper, ball, or disc is held open by forward flow and is pushed closed against its seat the instant flow tries to reverse — no external operation or actuation is needed; the valve responds purely to the direction of pressure differential across it.

5.2 Where Used

NRVs protect equipment and prevent backflow of produced fluids, mud, or cement in both surface piping and downhole completion strings (see also the downhole NRV covered in the Subsurface Production Tools document).

5.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Non-return / check valve working — search (YouTube)

Reference: Types and Applications of Choke Valves (What Is Piping)

6. Bean, Bean Housing, Bean Wrench and Bean Nozzles

6.1 Bean and Bean Housing

The “bean” (choke bean or nozzle) is a removable, precisely sized orifice insert fitted inside the bean housing on a choke assembly. By selecting a bean of a particular bore size — conventionally measured in 64ths of an inch — the operator sets a fixed flow restriction at the wellhead.

6.2 Working Principle

Produced fluid passing through the small fixed bore of the bean undergoes a sharp pressure drop, converting high reservoir-driven wellhead pressure into a lower, controlled downstream pressure. This protects downstream equipment, helps prevent sand production or coning by limiting drawdown, and sets a stable production rate for the well.

6.3 Bean Wrench

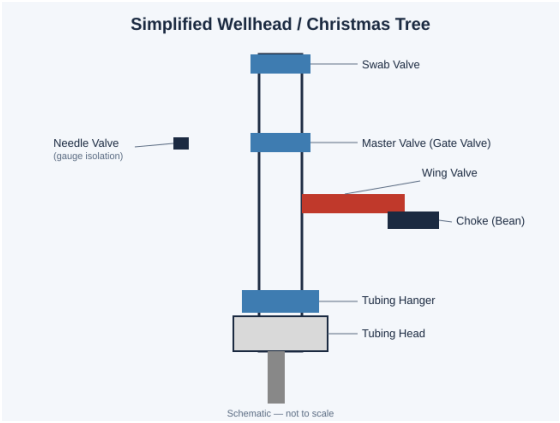
The bean wrench is a purpose-shaped spanner used to remove and install the bean within the bean housing without damaging the housing threads or the bean seat — a simple but important tool, since hand tools not matched to the bean profile can easily round off the fitting or damage the sealing surface.

6.4 Bean Nozzles

Bean nozzles are the interchangeable choke inserts referenced above. A field crew typically keeps a graduated set of nozzles on hand so the choke size can be changed quickly in response to well performance, clean-up requirements after stimulation, or periodic liquid unloading needs.

6.5 Restored Tools — Photograph & Schematic

Bean housing (choke body), restored



Choke position in wellhead stack

6.6 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Choke bean wellhead — search (YouTube)

Reference: How Does a Choke Valve Work? (TOT Valve)

7. Hammer Union

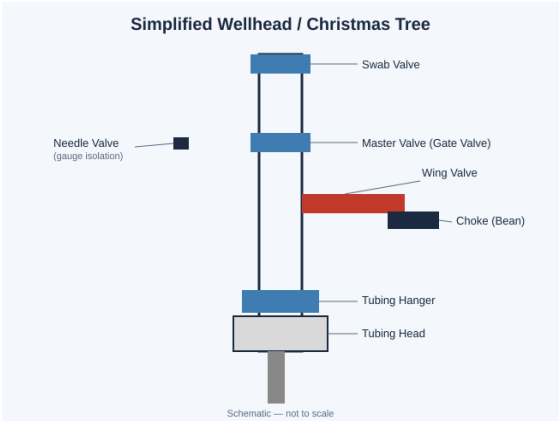
A hammer union is a quick-connect threaded coupling used to join sections of high-pressure surface piping, such as cementing lines, well-testing lines, or frac iron.

7.1 Working Principle

The union's large, wing-nut-style collar threads onto a matching sub on the adjoining pipe section. Rather than requiring a torque wrench, the wings are tightened or loosened by striking them with a hammer, allowing rapid make-up and break-out in the field without specialised torque tools — a significant time saving when rigging up and down high-pressure lines repeatedly.

7.2 Restored Tool — Photograph & Schematic

Hammer Union, restored — Production Engineering Laboratory, DUIET



Surface line connections (schematic)

7.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

[Video: Hammer union oilfield make-up — search (YouTube)]

[Reference: Wellhead Equipment News (ZS Oilfield Equip)]

8. Pressure Gauge

Pressure gauges are fitted at key points on the wellhead, choke manifold, and surface lines to give a continuous visual readout of system pressure.

8.1 Working Principle

Most field pressure gauges use a Bourdon tube — a curved, flattened metal tube that straightens slightly under internal pressure. This small mechanical movement is mechanically linked to a needle on a calibrated dial, giving a direct, no-power-required pressure reading.

8.2 Why It Matters

Continuous, reliable pressure readings at the wellhead, casing annulus, and choke manifold support safe well-control decisions and routine production monitoring — sudden pressure changes are often the first visible indicator of a developing well problem.

8.3 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Wellhead pressure gauge — search (YouTube)

Reference: Choke Valves, Types and Purpose (AQE Machinery)

9. Tubing Hanger

The tubing hanger is the component that lands inside the tubing head (or tubing spool) and suspends the entire production tubing string from the wellhead, while also sealing the annulus between the tubing and the casing below the Christmas tree.

9.1 Working Principle

The tubing hanger has a beveled outer surface that lands on a matching conical seat inside the tubing head, creating a metal-to-metal seal at the landed position. The hanger's central bore is aligned with and threaded to the top of the production tubing string, so the full weight of the tubing hangs from the hanger, which in turn rests on the tubing head. O-ring or elastomeric seals in grooves around the hanger body provide a secondary seal against the tubing head bore, isolating the tubing-casing annulus from the produced fluid inside the tubing.

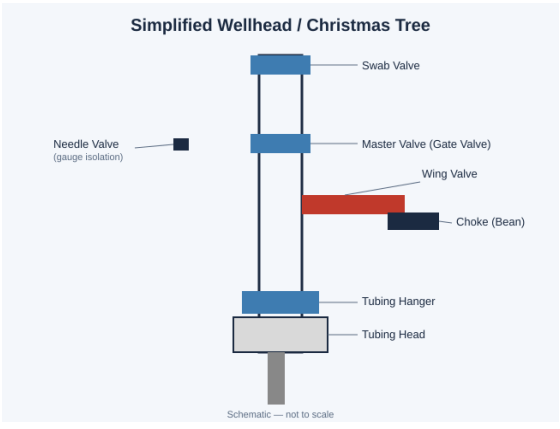
9.2 Additional Functions

- Many tubing hangers include one or more side ports for control lines, chemical injection lines, or downhole gauge cables to pass through the wellhead without compromising the pressure seal.
- The top of the tubing hanger typically provides the connection point for the Christmas tree above, aligning the tree's production bore directly with the tubing bore below.
- Some designs include a back-pressure valve (BPV) profile in the bore, allowing a temporary plug to be set in the hanger so the tree can be removed or serviced without killing the well.

9.3 Why It Matters

The tubing hanger is the mechanical and pressure-sealing link between the completion string below and the Christmas tree above — its correct landing and seal integrity are essential both for safely suspending the tubing string and for maintaining well control at surface throughout the producing life of the well.

9.4 Schematic



Wellhead valve assembly, restored (for context)	*Tubing hanger position in wellhead stack*

9.5 Video & Reference — Scan to Access

Scan: Video

Scan: Reference

Video: Tubing hanger wellhead animation — search (YouTube)

Reference: Production Wellhead Equipment (Vault Pressure Control)

10. Summary Table

Tool	Primary Function	Typical Location
Gate Valve	Full on/off block service, low pressure drop	Master/wing valve, tree
Needle Valve	Precise small-flow metering	Instrument & gauge lines
Ball Valve	Fast quarter-turn on/off shutoff	Production/test lines
NRV	One-way flow, prevents backflow	Surface lines & completions
Bean / Bean Housing	Fixed-bore flow restriction & pressure control	Choke assembly
Bean Wrench	Removes/installs bean without damage	Choke assembly maintenance
Hammer Union	Quick-connect high-pressure pipe coupling	Cementing/testing lines
Pressure Gauge	Visual pressure readout for monitoring	Wellhead, manifold, lines
Tubing Hanger	Suspends tubing string, seals annulus	Tubing head, below tree

This concludes Section 4 of the Production Engineering Laboratory tool reference series.